

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



for
UTILITIES SYSTEMS
(3E4X1)

MODULE 21
EQUIPMENT

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REVIEW ANSWER KEY Key-1

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

OPR: HQ AFCESA/CEOT

Certified by: HQ AFCESA/CEO
(Colonel Lance C. Brendel)

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INTRODUCTION

Before starting this AFQTP, refer to and read the “Trainee/Trainer Guide” located on the AFCESA Web site <http://www.afcesa.af.mil/>

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. *It is important for the trainer and trainee to understand* that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

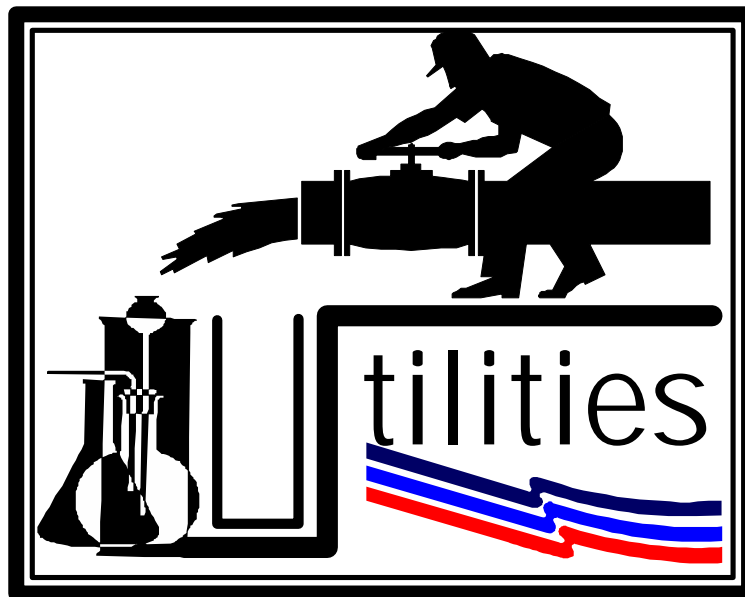
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOT revised this AFQTP. If you have any recommendations for improving this document, please contact the Structural Career Field Manager at the address below.

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PUMPS

MODULE 21

AFQTP UNIT 2

CENTRIFUGAL (21.2.4.1.)

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CENTRIFUGAL

Task Training Guide

STS Reference Number/Title:	21.2.4.1., Centrifugal
Training References:	<ul style="list-style-type: none">• TEL-A-TRAIN Video, Troubleshooting Centrifugal Pumps
Prerequisites:	<ul style="list-style-type: none">• Possess as a minimum a 3E4X1 AFSC.
Equipment/Tools Required:	<ul style="list-style-type: none">• General Hand tools
Learning Objective:	<ul style="list-style-type: none">• Trainee will successfully and safely repair centrifugal pumps.
Samples of Behavior:	<ul style="list-style-type: none">• Trainee will understand how to repair centrifugal pumps.
Notes:	

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CENTRIFUGAL

REFER TO VIDEO: *TROUBLE SHOOTING CENTRIFUGAL PUMPS* BY: *TEL-A-TRAIN (A WESTSCOTT CO.*

Background: If you were told to go fix a piece of equipment without knowledge of the components, it would be difficult to repair. Let's discuss the basic components of a centrifugal pump, (See Figure 1).

In a pump assembly, the *impeller*, *shaft* and *bearings* are components of the "rotating element." This "rotating element" is usually removed and installed as a unit in the pump frame. The impeller is turned by the shaft in an enclosed environment. The shaft is kept straight, balanced and true by the upper and lower bearings.

Impellers are mounted on the tapered end of a pump shaft. Slots ("key ways") in the tapered end of the pump shaft and the inside lip of the impeller hub are aligned and kept in place using a "key" (*a square piece of metal stock*), or shear pin. The key keeps the impeller spinning with the shaft when the pump is turned on. The impeller is kept on the pump shaft by the impeller nut and the impeller washer.

The pump shaft is usually constructed from stainless steel, and is usually the single most expensive component of a pump. Most shafts are fitted with a replaceable "shaft sleeve." The purpose of the shaft sleeve is to protect the pump shaft during rotation. All vertical or horizontal pumps have two bearings pressed onto each end of the shaft. Without the ball bearings, a shaft will not be able to rotate with ease and balance when revolving at high speeds.

The main purpose of the pump frame is to support and attach the driver to the pump; the driver being a motor. A coupling is used to connect the motor shaft to the pump shaft, absorb the force of the driver and to allow for slight misalignments between the pump and driver. The type of coupling used depends upon the manufacturer specifications. The stuffing box of the pump frame contains packing which is used to seal the pump.

SAFETY:

REMEMBER TO REMOVE ALL JEWELRY BEFORE REPAIRING PUMPS, DE-ENERGIZE CIRCUIT TO MOTOR AND CLOSE VALVES TO ISOLATE FLOW TO PUMP.

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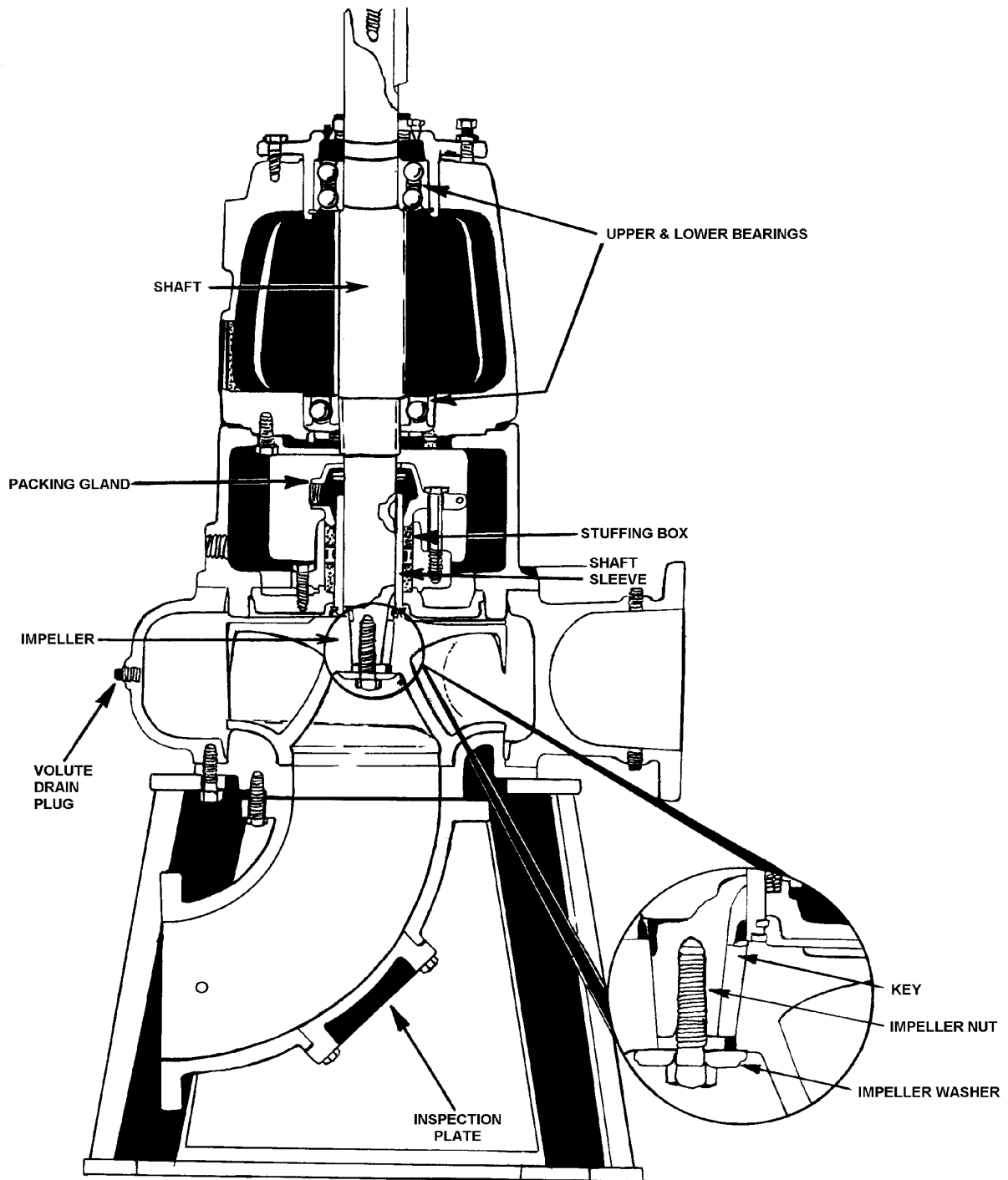


Figure 1, Centrifugal Pump

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Review Questions for Centrifugal

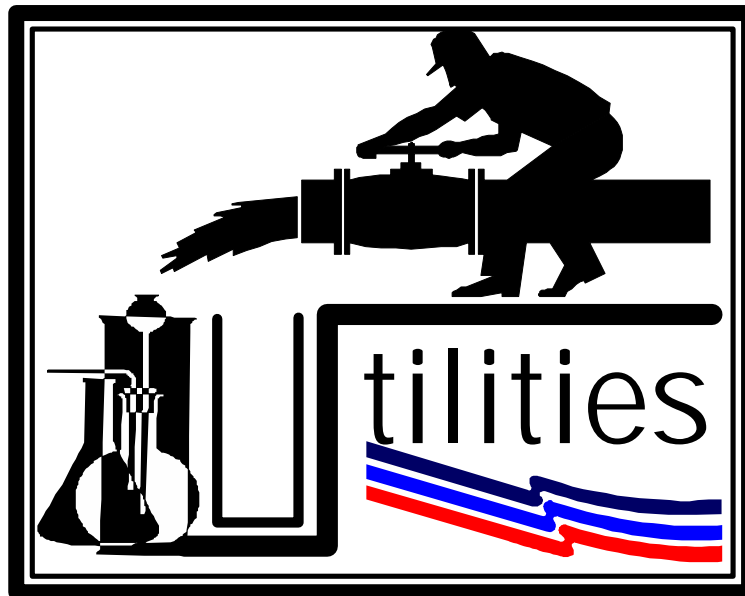
Question	Answer
1. The impeller, shaft and bearings are components of a unit called?	a. The stuffing box b. The packing gland c. The revolving unit d. The rotating element
2. What is mounted on the tapered end of a pump shaft?	a. Impellers b. Flanges c. Glands d. Non of the above
3. The impeller is kept on by what items?	a. Shear pin b. Shear key c. Impeller nut and washer d. None of the above
4. Name the safety precautions you must follow before repairing a centrifugal pump?	a. Remove jewelry b. De-energize power c. Close isolation valves d. All of the above
5. Why is it important to keep the pump shaft and drive shaft aligned?	a. To prevent pump from dripping b. To prevent bearings from being damaged c. To keep the shaft lubricated d. To keep the bearings cool
6. Give the two functions of pump seals.	a. Stability and friction b. Stability and cooling c. Cooling and friction d. Lubrication and cooling
7. Only the packing that is damaged must be removed when replacing packing material.	a. True b. False
8. When replacing packing it must be installed staggered every quarter turn or every 90 degrees.	a. True b. False

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CENTRIFUGAL

Performance Checklist		
Step	Yes	No
1. Did the trainee identify the equipment/tools needed?		
2. Did the trainee take safety precautions?		
3. Did the trainee complete the questions in QTP?		
4. By viewing the prescribed video, did trainee understand the procedure to repair centrifugal pumps?		
5. By viewing the prescribed video, did trainee successfully follow the procedures to repair centrifugal pumps?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



PUMPS

MODULE 21

AFQTP UNIT 2

POSITIVE DISPLACEMENT (21.2.4.2.)

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POSITIVE DISPLACEMENT

Task Training Guide

STS Reference Number/Title:	21.2.4.2., Positive Displacement
Training References:	<ul style="list-style-type: none">• CDC 3E451A
Prerequisites:	<ul style="list-style-type: none">• Possess as a minimum a 3E4X1 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none">• Positive displacement pump
Learning Objective:	<ul style="list-style-type: none">• Repair procedures of a positive displacement pump
Samples of Behavior:	<ul style="list-style-type: none">• Trainee should know the common repairs to be made on a positive displacement pump.
Notes:	

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POSITIVE DISPLACEMENT

Background: The most commonly known positive displacement pump you will be concerned with is known as a diaphragm pump or “mud hog”. It is virtually trouble free, and can be run without water for short periods without hurting the pump. The main areas of repair for the mud hog are the clapper valves and the diaphragm.

The clapper valves control the direction of flow of the water being pumped. Clogging of the clapper valve by rocks, sticks and other debris is one of the common problems with the diaphragm pump. Another area of the pump that could give you problems is the diaphragm itself. Rips, tears, and holes in the diaphragm will reduce or render its operation ineffective.

You will need to follow the manufacturers specifications when changing the clapper valve or the diaphragm. Each clapper valve will have gaskets that can be made out of a suitable gasket material.

HINT:

Because there are many styles of positive displacement pumps, the following steps are associated with the most basic unit. Always consult the manufacturer’s manual before operating your unit.

One of the most important things to consider before repairs can be made is to troubleshoot and identify the problem. For example...

The pump is running; however, water is not being discharged. Your pump is not primed.

To troubleshoot the pump, follow these steps:

Step 1: Check suction hose to see if it is fully submerged, or if it is clogged with mud or debris.

Step 2: Check suction hose for holes that would break the suction and prevent priming.

HINT:

To fix holes in the hose, if replacement hose is not on hand, you can apply duct tape, or pack a mud cake over the hole, to prevent air from getting in until replacement can be made.

Step 3: Check clapper valves to see if they are seated properly.

- If the clapper valve gasket is ripped, torn, or is deformed it will need to be replaced.

Step 4: Remove diaphragm housing so you can visually inspect the rubber for rips, tears, dry rot, or any indication of malfunctions.

- If the diaphragm is damaged it will have to be replaced following the manufacturers specifications.

HINT:

Replace the diaphragm if any of the above problems were noted. If no problems were noted this would be a good time to apply a light coat of lubricant to the rubber.

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These steps, if followed, should eliminate any problems that could arise with this pump. If you still have problems you should refer to the manufacturers manual for further instructions.

SAFETY:

ENSURE THAT PUMP IS NOT RUNNING AND SPARK PLUG IS DISCONNECTED WHILE PERFORMING ANY OF THE PRECEDED REPAIR INSTRUCTION'S.

**Review Questions
for
Positive Displacement**

Question	Answer
1. What are the places you check if you are not getting a prime?	a. Hoses, clapper valves, and diaphragm b. Housing, clapper valves, and diaphragm c. Housing, gate valves, and diaphragm d. Housing, hopper valves, and clam valves
2. What can be used to temporarily repair a leaky suction hose ?	a. Masking tape or a rag b. Duct tape or pack with mud c. Temporary repairs are impossible d. Masking or pack with electrical tape
3. What do you do if there is a hole in the diaphragm?	a. Patch it b. Tape it c. Replace it d. Disregard it
4. What do you use to repair the diaphragm in the pump?	a. Common sense b. Packing pullers c. CDCs d. Manufacturers manuals

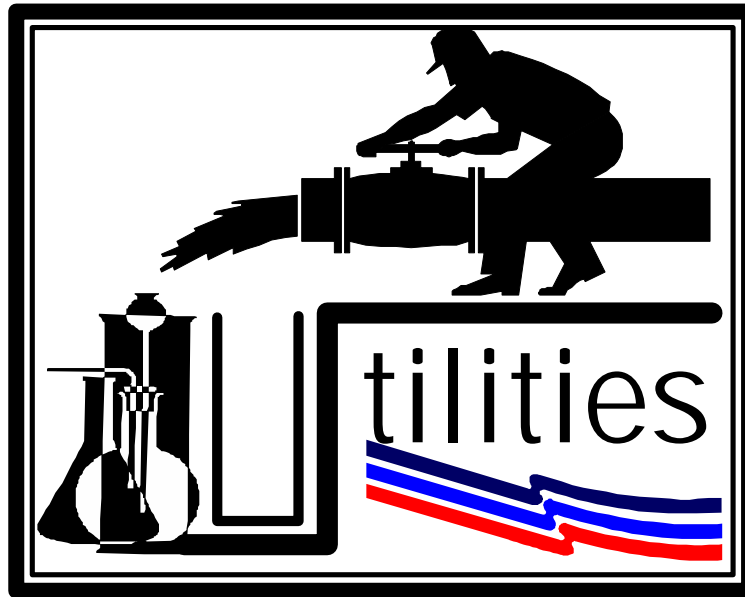
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POSITIVE DISPLACEMENT

Performance Checklist		
Step	Yes	No
1. If the Pump did not prime, did trainee:		
a. Check hoses.		
b. Check end of hose for obstruction.		
c. Check clapper valves.		
d. Check diaphragm.		
e. Replace clapper valve gaskets if needed.		
f. Replace diaphragm if needed.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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OPERATE AND MAINTAIN PUMPS

MODULE 21

AFQTP UNIT 3

CENTRIFUGAL (21.3.1.)

POSITIVE DISPLACEMENT (21.3.2.)

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CENTRIFUGAL POSITIVE DISPLACEMENT

Task Training Guide

STS Reference Number/Title:	21.3.1., Centrifugal 21.3.2., Positive displacement
Training References:	<ul style="list-style-type: none"> • CDC 3E451A Vol. 4 (Waste Systems) • Maintaining Centrifugal Pumps Study Guide, TEL-A-TRAIN, Inc. • Maintaining Centrifugal Pumps Video, TEL-A-TRAIN, Inc.
Prerequisites:	<ul style="list-style-type: none"> • Possess as a minimum a 3E4X1 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none"> • General Hand tools,
Learning Objective:	<ul style="list-style-type: none"> • Trainee will successfully and safely operate and maintain centrifugal pumps.
Samples of Behavior:	<ul style="list-style-type: none"> • Trainee will understand how to operate and maintain shop centrifugal pumps.
Notes:	

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CENTRIFUGAL

POSITIVE DISPLACEMENT

Background: The words “operation” and “maintenance” go hand-in-hand. If you don’t operate a pump properly, you will be maintaining it more often. Conversely, if you do not maintain a pump properly, you will not be operating it with any reliability for long. It is therefore important that you understand this basic principle, “Mechanical equipment will run well and have a longer life if it is not abused and it is serviced according to the required standards.” An operator must understand some of the basic components of pump operation. Remember, pump operation and maintenance is the single-largest maintenance item in water booster stations, and sewage lift station operations.

Centrifugal pumps (Figure 1), work on the same principle as a fan. In a centrifugal pump, the rotating blades of an impeller, force fluid away from the center of the pump, creating a depression in the middle. The fluid is forced out the discharge side under pressure. Centrifugal force is the principle by which most modern pumps work. This principle is the basis of how an impeller expels a liquid outwards. Consequently, the impeller is the heart of any centrifugal pump. Everything on a pump is geared towards the impeller.

The main parts of all centrifugal pumps are the impeller, the motor, the seals (*mechanical or packing*), the casing, the discharge side and the suction side. Each part has an important role to play. But remember, the impeller is the main component behind the centrifugal principle.

By watching the TEL-A-TRAIN video, (*Maintaining Centrifugal Pumps*), you will understand the importance of maintaining centrifugal pumps and the step-by-step procedures to preventive maintenance.

TEL-A-TRAIN (MAINTAINING CENTRIFUGAL PUMPS REVISED) 309 MARKET STREET CHATTANOOGA, TN. 37405
1-800-251-6018 FAX: 523-267-2555

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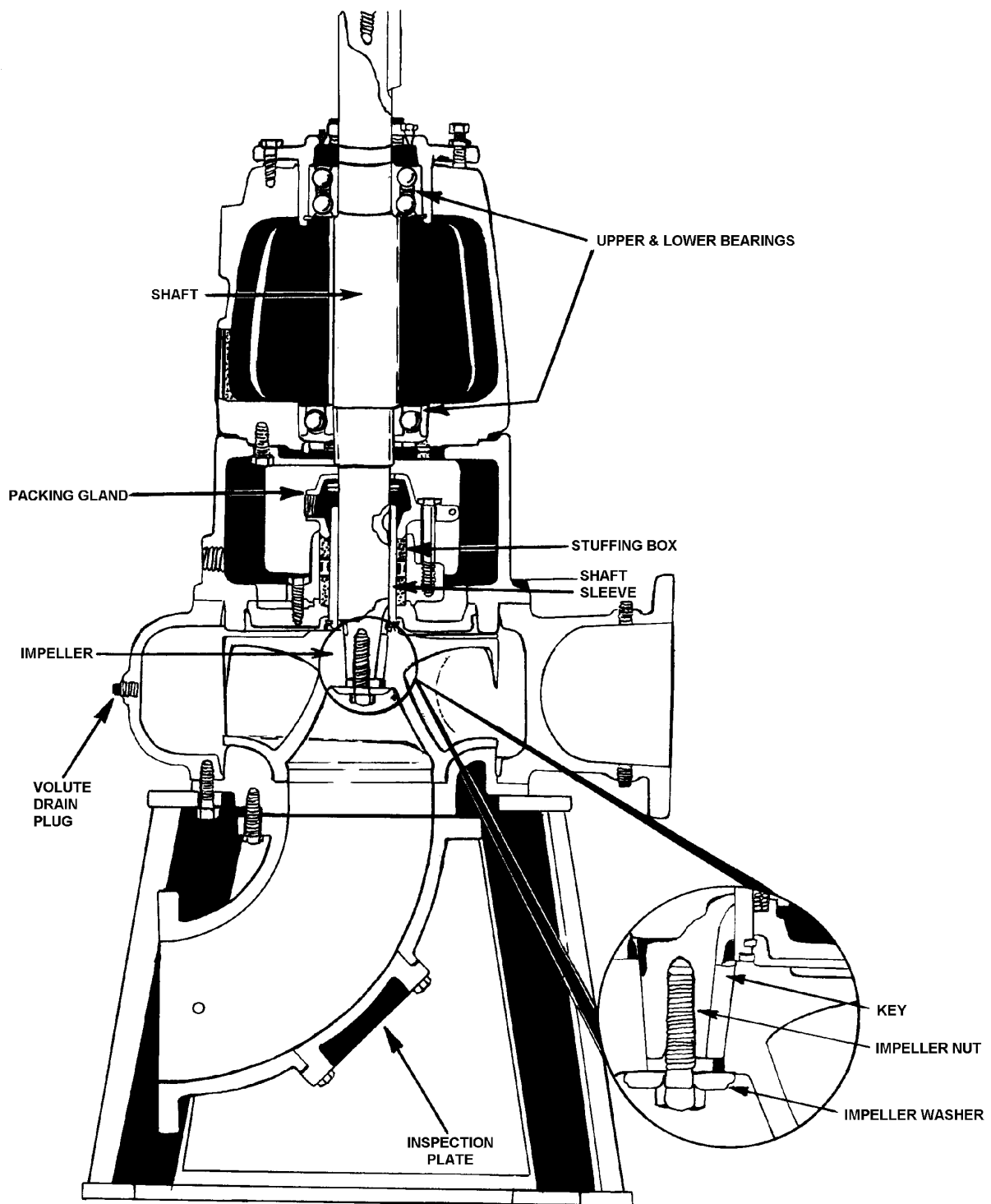


Figure 1, Centrifugal Pump

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Review Questions for Centrifugal

Positive Displacement

Question	Answer
1. Good operation & maintenance will provide _____.	a. Longer pump life b. Good operation c. Less major complications d. All of the above
2. Centrifugal force pumps fluids _____.	a. Inwards only b. Outwards only c. Either inwards or outwards d. Neither inwards nor outwards
3. The “heart” of the centrifugal pump is the _____.	a. Impeller b. Shaft c. Bearings d. Packing
4. Centrifugal pumps may be sealed using _____.	a. Rubber gaskets b. Synthetic o-rings c. Mechanical or packing seals d. None of the above

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CENTRIFUGAL
POSITIVE DISPLACEMENT

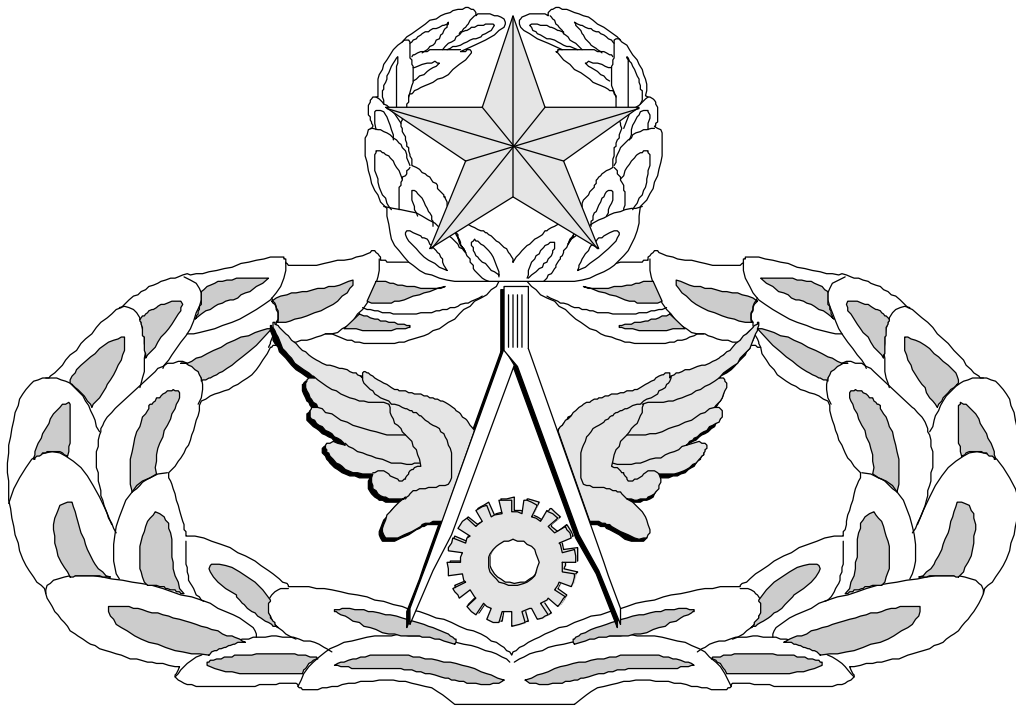
Performance Checklist		
Step	Yes	No
1. By watching the video prescribed, did the trainee identify all the equipment needed for operating and maintaining centrifugal pumps?		
2. By watching the video prescribed, did the trainee take proper safety procedures?		
3. By watching the video prescribed, did the trainee know the proper procedure to maintaining centrifugal pumps?		
4. By watching the video prescribed, did the trainee understand the principles and procedures to operate and maintain centrifugal pumps?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For
UTILITIES SYSTEMS

(3E4X1)

MODULE 21

EQUIPMENT

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CENTRIFUGAL

(3E4X1-21.2.4.1.)

Question	Answer
1. The impeller, shaft and bearings are components of a unit called?	d. The rotating element
2. What is mounted on the tapered end of a pump shaft?	a. Impellers
3. The impeller is kept on by what items?	c. Impeller nut and washer
4. Name the safety precautions you must follow before repairing a centrifugal pump?	d. All of the above
5. Why is it important to keep the pump shaft and drive shaft aligned?	b. to prevent bearings from being damaged
6. Give the two functions of pump seals.	c. Lubrication and cooling
7. Only the packing that is damaged must be removed when replacing packing material.	b. False
8. When replacing packing it must be installed staggered every quarter turn or every 90 degrees.	a. True

POSITIVE DISPLACEMENT

(3E4X1-21.2.4.2.)

Question	Answer
1. What are the places you check if you are not getting a prime?	a. Hoses, clapper valves, and diaphragm
2. What can be used to temporarily repair a leaky suction hose ?	b. Duct tape or pack with mud
3. What do you do if there is a hole in the diaphragm?	c. Replace it
4. What do you use to repair the diaphragm in the pump?	d. Manufacturers manuals

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CENTRIFUGAL (3E4X1-21.3.1.)

POSITIVE DISPLACEMENT(3E4X1-21.3.2.)

Question	Answer
1. Good operation & maintenance will provide _____.	d. All of the above
2. Centrifugal force pumps fluids _____.	b. Outwards only
3. The “heart” of the centrifugal pump is the _____.	a. Impeller
4. Centrifugal pumps may be sealed using _____.	c. Mechanical or packing seals

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